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# RECENT RESEARCHES INTO THE EPIDEMIOLOGY OF MALTA FEVER.

By Colonel DAVID BRUCE, C.B., F.R.S., D.Sc.,
Royal Army Medical Corps; Chairman, Mediterranean Fever Committee of the Royal Society.

(*Read: Friday, February 15th*, 1907.)

The subject of this evening's Paper is "Recent Researches into the Epidemiology of Malta Fever." In this place it is not necessary to go into any detail in regard to the history or symptoms of this fever, but a few introductory words will not be amiss.

Malta fever, as you are all aware, is a disease of long duration, averaging four months, but in some cases dragging out its weary length for one, two, or even three years. The temperature-curve is characterised by extreme irregularity, fresh exacerbations of fever being frequent. Another prominent feature of this fever is the presence of symptoms of a rheumatic or neuralgic character. Few marked cases pass through their course without the occurrence of painful and swollen joints, or neuritis in various nerves, which combine with the prolonged temperature to bring the patient to a condition of extreme anæmia and debility, from which recovery to health is slow.

I think I have said enough of the nature of this fever to impress upon those of you who are not familiar with it the importance and severe nature of the disease under discussion.

## Historical.

Let me say a word in regard to the history of Malta fever. This fever has naturally been chiefly worked at by Army medical officers, who have come in contact with it among the garrisons in Malta, Gibraltar, Cyprus, or at Netley Hospital. Those interested in its history should read the old accounts of it by Marston, in 1863, and Veale, in 1881. At that time it was generally considered to be malarious in origin, and was usually returned as remittent fever; but the most severe cases were often returned as enteric, and the very mild as febricula or simple continued

fever. In 1887, the specific micro-organism, the *Micrococcus melitensis*, was discovered, which effectually separated it from other continued fevers, and it found a place in the third edition of the *Nomenclature of Diseases*, published in 1896. In 1904, as the incidence of this fever among the garrison of Malta had increased to a marked extent, the Royal Society, at the request of the Admiralty, War Office, and Colonial Office, undertook its further investigation, and sent out a small commission to Malta for that purpose. This commission has been at work during the summers of 1904, 1905, and 1906, and the Royal Society has already published seven volumes of reports. It is a summary of the work done by this commission which forms the subject of this Paper.

## Geographical Distribution.

In regard to the geographical distribution of this fever, a few words will suffice. One curious thing is, that it has almost or quite disappeared of late years from Gibraltar, where some years ago it was very prevalent. In the Mediterranean it undoubtedly occurs in such places as Tunis, Algiers, and Alexandria, as well as in Malta. It also occurs in such widely-separated places as South Africa, India, China, the Philippine Islands and America. It has, therefore, a world-wide distribution, although nowhere does it seem to occur in such numbers as in Malta.

In regard to other etiological factors, such as the influence of age and sex, of occupation, length of residence, climatic conditions, etc., I must refer you to the Reports, where these matters are entered into very fully. Permit me, however, to glance briefly at one or two points which I consider of interest.

## Social Position.

Here we come against a curious fact, and one which it was impossible to explain until lately. It may be stated, broadly, that the better the social position the more the liability to this disease. Officers and their wives and families, living in large, airy, and clean houses, suffer more frequently than the men in their more crowded barrack-rooms. In fact, the risk of the military and naval officers to take this fever is more than three times as great as in the case of the men.

This higher incidence among the officers cannot be explained by sanitary conditions, by convection of the

disease by mosquitoes, or by inhalation of infected dust, or any of the theories usually held; as the officer is, if anything, less exposed to these influences than the men.

## Climatic Conditions.

The climate of Malta, as you are aware, is extremely hot and dusty from about the middle of June to the middle of October, while the winter months are correspondingly bleak and wet. Now, although the number of cases of Malta fever do show a marked increase in summer, yet it is a disease which is prevalent all the year round: one-third as many cases occurring in the coldest and rainiest months as in the hottest and dustiest. Another fact of interest is, that if we study the incidence of Malta fever in individual years, we are struck by its irregularity: a large number of cases suddenly appearing in February or December, or other of the cold and rainy months. It was found difficult to reconcile these facts with mosquito or dust theories of propagation.

## Distribution of Malta Fever among the Civil Population.

Until recently it was supposed by many of us that this fever was restricted to the inhabitants of the cities surrounding the Grand Harbour. This was in the days when the theory was held that the virus was carried in sewer air or other foul gases. As the Grand Harbour in those days was a huge cesspool—the drainage of the cities falling into it—there was some excuse for a belief in the theory. Malta fever is now known to occur in every part of Malta, and, in fact, the very general distribution of the fever is very striking. It is not the cities round the harbours which are struck most heavily, some of the inland towns and villages showing a much greater incidence.

It is evident, then, that the incidence of Malta fever cannot depend upon sanitary conditions, since the greatest variety exists, from the paved, drained, swept Valletta, to the inland towns and villages where the most insanitary conditions prevail. It cannot depend on the water supply, since there is often a larger number of cases in towns with an excellent supply of pure water than in towns which depend for their supply on shallow wells. The cause must be sought in something which affects all classes and all conditions of life.

## Distribution among the Garrison.

Next I would draw your attention to the prevalence of this disease among our soldiers and sailors in Malta, in order to impress upon you the importance of this disease to the State. Among the soldiers—who average, as a rule, about 8,000—there is an average yearly incidence of 37.6 per 1,000, or 312 admissions to hospital every year for Malta fever.

Among the sailors there in an incidence of 28.55 per 1,000, or about the same number of admissions to hospital as among the soldiers.

Now, as the average duration of this disease may be put down at four months, it means that some 624 soldiers and sailors are in hospital 120 days, which makes 74,880 days of illness. What an amount of personal suffering and loss to the State this sickness and the subsequent invaliding entail it is impossible to estimate, but the mere pecuniary loss must be very considerable.

## Micrococcus melitensis.

It is evident from the foregoing account that little light has been thrown on the etiology of this disease by a study of sanitary conditions, effect of climate, age and sex, length of residence, occupation, food or water-supply, etc. It is therefore necessary to turn to the laboratory to see if anything can be discovered from a study of the micro-organism which causes the disease. The *Micrococcus melitensis* has been described so often that it is not necessary for me to describe it minutely. Suffice it to say that it is very minute, that it grows outside the body on artificial media, and that it can be distinguished from other micro-organisms by suitable tests.

The members of the commission entrusted with the laboratory work set themselves to study how this micro-organism leaves the body, how it behaves outside the body, and how it is able to again gain entrance to the body.

*How does the* Micrococcus melitensis *leave the Body?*—It is important, of course, to find out how a parasite leaves the body, as this may throw light on the mode of infection. Many experiments were made to try to discover it in the expired air, in the saliva, expectoration, sweat and scrapings of skin of patients; and finally it was decided that the principal path by which this micro-organism leaves the body is by way of the urine. It is true it also leaves the

body by way of the blood, by the agency of mosquitoes and other biting insects, but this only rarely and in extremely small numbers. The urine, on the other hand, sometimes contains the Micrococci in enormous numbers, though as a rule they are scarce, ranging from three or four to as many hundreds per cubic centimetre. The commission examined several thousand samples and found the Micrococcus in 10 per cent. This excretion of the parasite in the urine, taken in conjunction with its resistance to drying, was looked upon by the commission as a very probable factor in the spread of the disease, and many experiments were made on this hypothesis.

*Life of the* Micrococcus melitensis *Outside the Body. Vitality of the Micrococcus.*—Many experiments were made by the commission, the results of which went to show that this micro-organism is fairly resistant to external influences. It can exist in a dry condition, in dust or clothing, for two to three months. It lives in tap-water or sea-water for about one month. Even in urine which has decomposed and become markedly alkaline, it can live for a week. Exposure to direct sunlight kills it in a few hours.

*Habitat of the Micrococcus Outside the Human Body.*—Many attempts were made to discover this parasite outside the body. As the theories in vogue named insanitary conditions, sewer air, dust from infected places, the water of the harbour, etc., as causing this fever, diligent search was made in every likely place to discover this microbe, but up to the present with no success.

*How does the Micrococcus gain Entrance to the Body?*—It is on finding the correct answer to this question that the success of an investigation such as this probably hangs. Does the parasite gain entrance by way of the alimentary canal, by the lungs, through mucous membranes, or through the skin? In other words, is it conveyed from the sick to the healthy by means of food or drink, by contaminated dust, or by blood-sucking insects?

In trying to find out a means of stamping out a disease, it is important to try to narrow down the paths of infection. As long as yellow fever was thought to be spread by contact—infected clothes, food, water, etc.—nothing could be done. As soon as it was discovered that it was spread by a particular species of mosquito, the problem of prevention was simple. In the same way in Malta fever: if it can be spread by contact, contamination of food or water, by the inhalation of dust, sewer air, etc., it will be impos-

sible to do more than recommend the ordinary established rules of hygiene. But, on the other hand, if the mode of spread can be narrowed down to some one path, then stamping out the disease becomes possible. Let me, then, shortly discuss the experiments made by the commission to solve this question.

*By Contact.*—This is important, as questions of segregation, evacuation, and disinfection of barracks depend on this mode of infection. Experiments were made by placing monkeys in more or less intimate contact, and it was found that if the contact was quite intimate, infection does take place. If, on the other hand, the contact is less intimate, so that contamination of the food by infected urine was prevented, infection did not take place. It was concluded that the monkeys probably took the disease by having their food contaminated by the urine of their sick neighbours, and that therefore contact resolved itself into a feeding experiment.

As it is very unlikely that man has his food so grossly contaminated as in the case of the monkey, it is improbable that infection takes place, except very rarely, in this way.

In regard to this question of conveyance by contact, there is one argument against it which seems to me unanswerable, and that is, that thousands of cases of Malta fever have been invalided home to England and treated in our naval and military hospitals without, as far as I am aware, a single case of the fever arising among the patients, orderlies, or nursing sisters. We may therefore conclude that contact with Malta-fever patients, or the handling of infective clothing or discharges, is not the path by which the Micrococcus gains entrance to the body.

*By Dust contaminated by the* Micrococcus melitensis.—For some time it was considered probable that this would prove to be the common method of infection. The fact that the Micrococcus withstands drying for a long time, the dusty nature of Malta, and the probability that gross contamination of the surface of the soil takes place by infective discharge rendered this view likely.

Experiments were made to put the theory to the test. Dust was artificially contaminated with Micrococci, and blown about a room in which monkeys were confined, or blown into their nostrils or throat. Several of these experiments were successful. It was therefore proved that dust artificially contaminated with *Micrococcus melitensis* could give rise to the disease. This, however, was no proof

that this mode of infection occurs in Nature. The artificially-contaminated dust contained myriads of Micrococci. Under natural conditions they could seldom be numerous, and the powerful Maltese sunlight would tend to kill them off rapidly. The dust blown about by the wind must also dilute the Micrococci to an enormous extent; so that it is only possible to conceive of a Micrococcus here and there in a vast quantity of dust. Experiments were therefore made with dust contaminated with urine, in order more closely to resemble natural conditions. The commission made many experiments on these lines, but in no case with a successful result. Dust collected from suspicious places and blown about the cages, sprinkled on food or injected under the skin, also gave negative results.

The conclusion was therefore come to that conveyance of the infective germ by means of contaminated dust could only rarely, if ever, give rise to the disease.

*By Way of the Alimentary Canal.*—As it is most important to ascertain without a shadow of a doubt whether an infective micro-organism can enter by way of the alimentary canal, many feeding experiments were made. It had long been known that the smallest quantity of the Micrococci introduced under the skin, or applied to a scratch, would give rise to the disease in man and monkeys, but some previous work had cast doubts on infection by the mouth.

I need not bring the details of these experiments before you, but need only state that it has been abundantly proved that Malta fever can be conveyed to healthy animals by way of the alimentary canal. Even a single drink of fluid containing few Micrococci almost certainly gives rise to the disease.

*By Mosquitoes or other Biting Flies.*—As already mentioned, the theory had been advanced that Malta fever, like yellow fever and plague, might be conveyed by blood-sucking insects. The fact that the Micrococci are frequently found in the peripheral blood, although it must be confessed in very small numbers, gave some colour to the belief. The commission, therefore, fully investigated this question, and made numerous experiments with the different species of mosquitoes found in Malta, and also with other blood-sucking insects.

The results went to show that this mode of conveyance of the Micrococci from sick to healthy animals, if not absolutely negatived, can only be of the rarest occurrence.

Up to this point, then, the commission had shown by

experiment that the most probable way the Micrococcus gained entrance to the body was by the alimentary canal, and therefore by some infected food or drink. There was no evidence that contact, inhalation of infective dust, or mosquitoes, play any prominent *rôle*. But, on the other hand, the epidemiologists could see no reason for suspecting the water-supply or any particular food-stuff.

### Infection by means of Goats' Milk.

At last a discovery was made which threw a flood of light on the obscurities, and seemed to explain the epidemiological features of the disease. This was the remarkable discovery that the goats in Malta act as the reservoir of the virus of this fever. The discovery came about in this way. In an investigation of this sort, it is part of the work to examine the various surrounding animals, to find out if any of them are susceptible to the disease. The monkey was the only animal which was known to take the disease naturally, although some of the laboratory animals, such as the rabbit and guinea-pig, could be made to take the infection by various expedients, such as, for example, intracerebral inoculation. In this way the goat came under observation. The goat is very much in evidence in Malta, and supplies practically all the milk used. Flocks of them wander about the streets from morning till night, and are milked as required at the customers' doors. It must be confessed the commission had little hope that an examination of these animals would yield anything. As a matter of routine, however, several goats were inoculated with the Micrococcus, and the result watched. There was no rise of temperature, no sign of ill-health in any way ; but in a week or two the blood was found to be capable of agglutinating the specific micro-organism. Even then, the goat seemed such an unlikely subject for Malta fever, the observation was in danger of lapsing. Nothing more was done for several months, when, by accident, the matter came up again, and it was decided to repeat the inoculation experiments. A small herd was procured for the purpose, and, as an ordinary precautionary measure, their blood was examined before inoculation. Much to the surprise of the commission, several of them were found to react naturally to the agglutination test, and this led to the examination, and the discovery of the *Micrococcus melitensis* in the blood, urine, and milk. Some thousands of goats in Malta were then examined, and the epoch-making discovery was made that 50 per cent. of

the goats in Malta responded to the agglutination test, and that actually 10 per cent. of them were secreting the Micrococci in their milk. Thus the long and tedious investigation of this fever was beginning to bear fruit. Monkeys fed on milk from an affected goat, even for one day, almost invariably took the disease. At this time, curiously enough, an important experiment on the drinking of goats' milk by man took place accidentally. This is the case of the s.s. *Joshua Nicholson*, which has been fully described by Staff-Surgeon Clayton, in Vol. VII of the *Reports of the Commission*. Shortly, the story is as follows:—In 1905 the s.s. *Joshua Nicholson* shipped sixty-five goats at Malta for export to America. The milk was drunk in large quantities by the captain and the crew, with the result that practically everyone who drank the milk was struck down by Malta fever. There is no need for me to go into the details, as these can be read in the *Report*. I may add, however, that sixty of the goats (five having died) on arrival in America, were examined, and thirty-two found to give the agglutination reaction, while the *Micrococcus melitensis* itself was isolated from the milk of several of them.

This epidemic of Malta fever on board the *Joshua Nicholson* furnishes, in my opinion, the clearest proof possible of the connection of Malta fever in man with the Maltese goat.

Another proof of this connection is given by Major Horrocks, the Sanitary Officer at Gibraltar, and published in Vol. V of the *Reports*. Twenty years ago, Malta fever was very common in Gibraltar, but since that time the incidence has gradually lessened, until it finally disappeared completely in 1904. Horrocks has made the curious and important observation that this disappearance of Malta fever from Gibraltar is associated with the disappearance of the Maltese goat. He says that, in 1883, practically all the goats on the Rock were Maltese, and at that time regular shipments of goats from Malta to Gibraltar took place. *Pari passu* with the withdrawal of grazing passes and the increase in the cost of shipment, the importation of goats from Malta ceased, and goat-keepers replaced their stock, partly by importation of Spanish goats and partly by breeding.

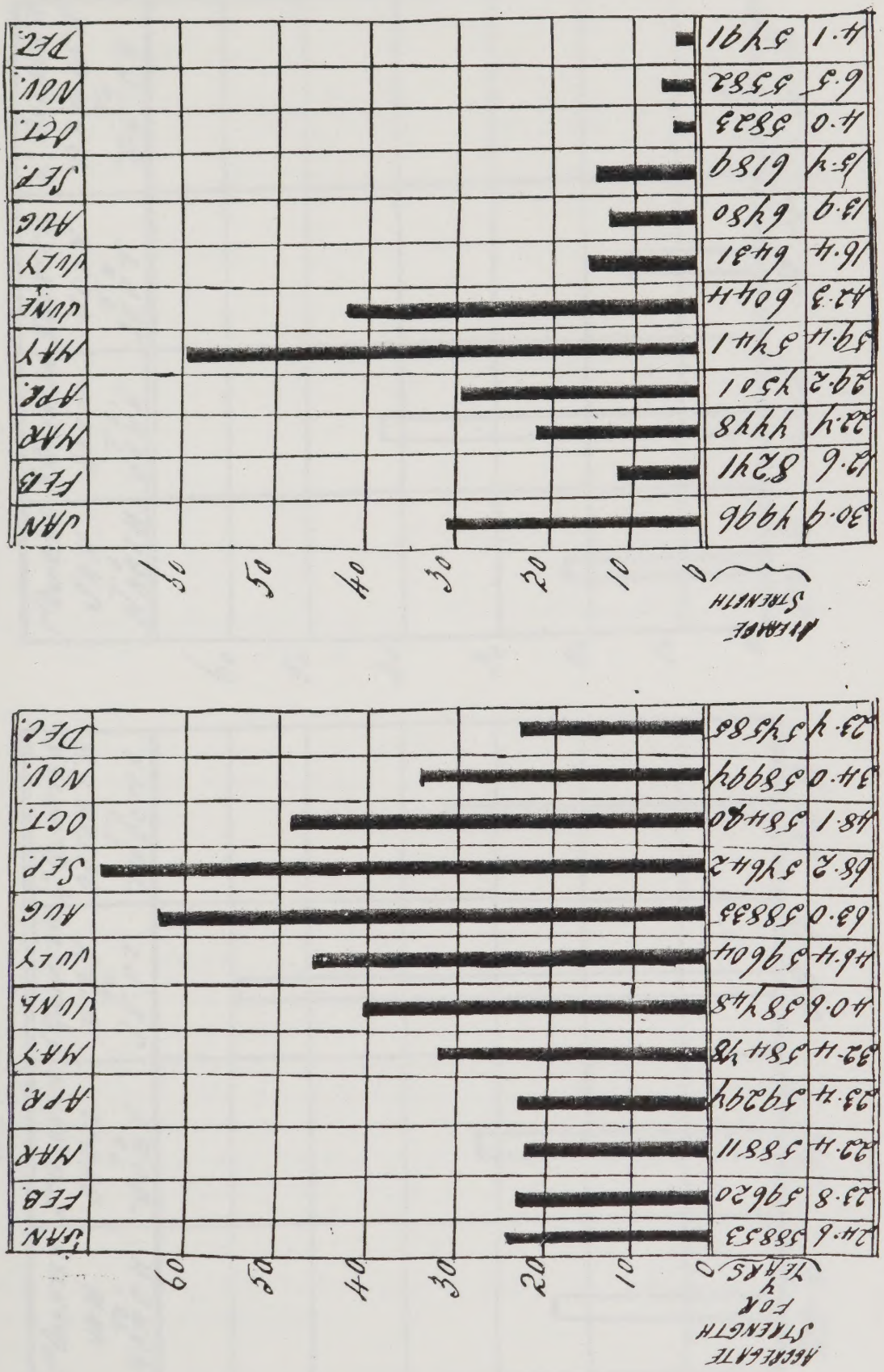
Here, then, at last, has been discovered a mode of infection which explains many of the curious features in the epidemiology of Malta fever; the irregular seasonal prevalence, the number of cases which occur during the winter

months, when there are no mosquitoes and little dust. It is true there are more cases in summer, but this may be explained by the temperature being more favourable for the multiplication of the Micrococcus in milk that has been set aside, and to the fact that more milk and cream is used for fruit, in ice-creams, etc. It explains the liability of the officer to attack being three times as great as in the case of the private soldier, since the former consumes much more milk in various ways than the latter. It also explains the isolated epidemics which sometimes occur at any season of the year in institutions or in messes, such as that published by Johnstone in Vol. II of the *Reports of the Commission*, where a sergeants' mess was severely struck while the men living in the vicinity escaped.

*Results of Measures directed against the use of Goats' Milk.*—Preventive measures, as a result of this inquiry, were first begun in Malta in June, 1906. Of course, much opposition and prejudice were met with at first; but, by dint of argument and explanation, most of the regiments and military and naval hospitals agreed to banish goats' milk from their dietary. The result is very striking, as is shown in the following charts, which give the number of cases of Malta fever among the soldiers in the garrison, before and after the preventive measures came into action.

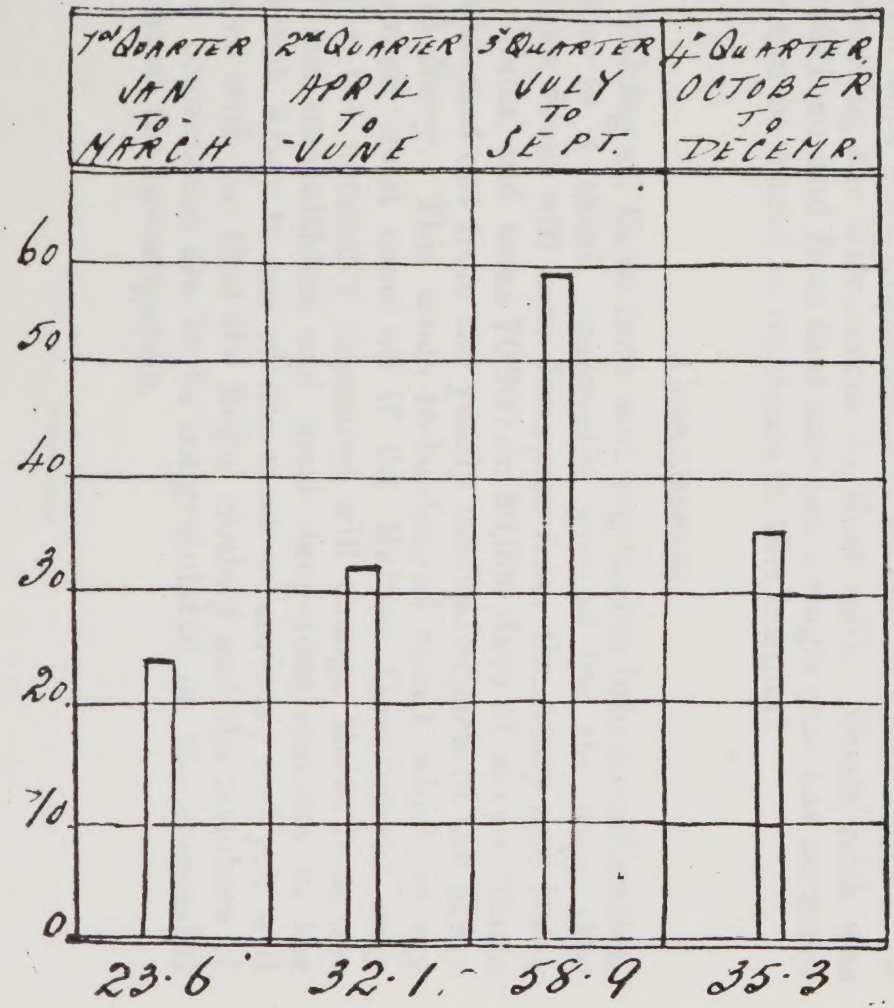
The preventive measures, it must be repeated, only came into practical use about the beginning of July, 1906, and a remarkable diminution in the incidence is at once seen. Broadly speaking, the cases dropped to one-tenth of what would have been their normal number. It will also be noted that 1906 began badly, there being an average incidence of 31.0 per 1000 for the first six months, against 27.6 per 1000 for the years 1899 to 1905.

Another striking example of the benefit of this simple preventive measure is given in the case of the Royal Naval Hospital, Malta. This hospital is a fine modern building, situated in extensive grounds, surrounded on three sides by the sea, with excellent drainage and water-supply, and beautifully kept. In spite of these advantages, this hospital has been in bad repute for years, on account of the number of cases of Malta fever which broke out among its inmates. According to Staff-Surgeon Clayton, who enters very fully into this question in his report, one-third of the cases of Malta fever which occur in the Navy can be traced to residence in this hospital. The goats supplying the hospital

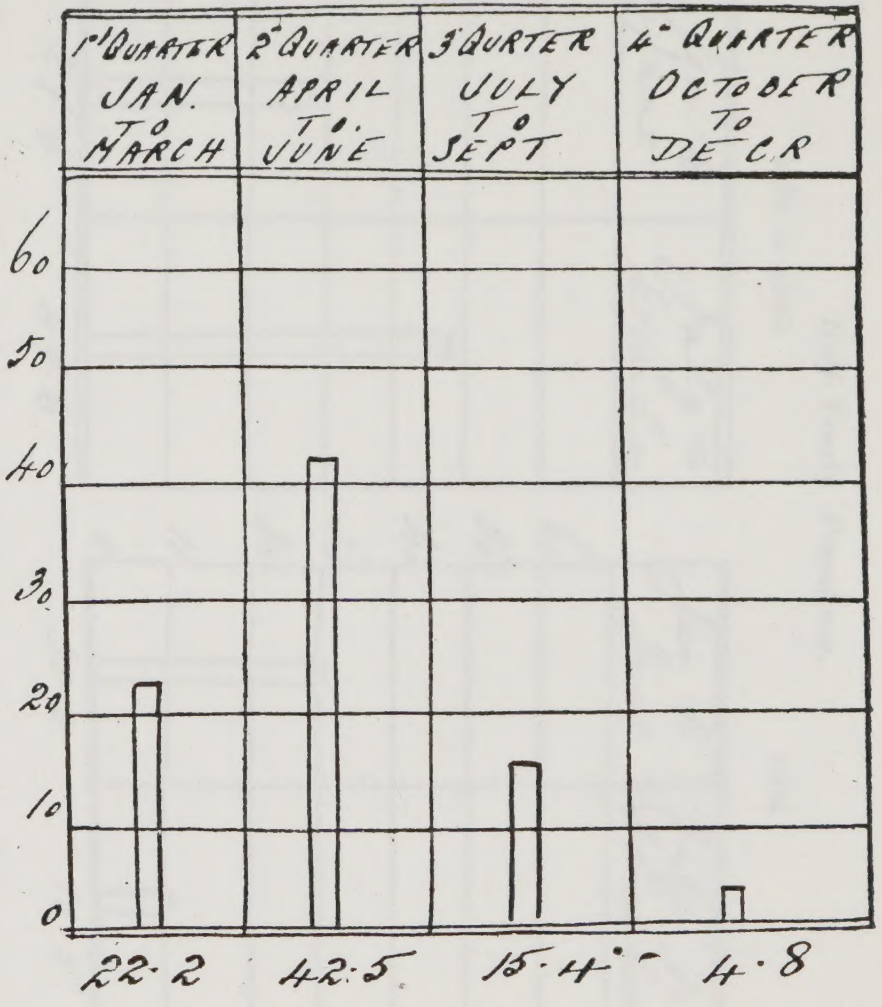

Monthly Prevalence: Ratio per 1000 of Strength, expressed in terms of an Annual Ratio.
1899 to 1905.
1906.
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEP. OCT. NOV. DEC.
60 50 40 30 20 10 0
MEAN STRENGTH
30·9 42·6 22·4 29·2 59·4 42·3 16·4 13·9 15·4 4·0 6·5 4·1
ASCERTAINED STRENGTH FOR YEARS
24·6 23·8 22·4 23·4 32·4 40·6 46·4 63·0 68·2 48·1 34·0 23·9

*Quarterly Prevalence: Ratio per 1000 of Strength, expressed in terms of an Annual Ratio.*

1899 to 1905.

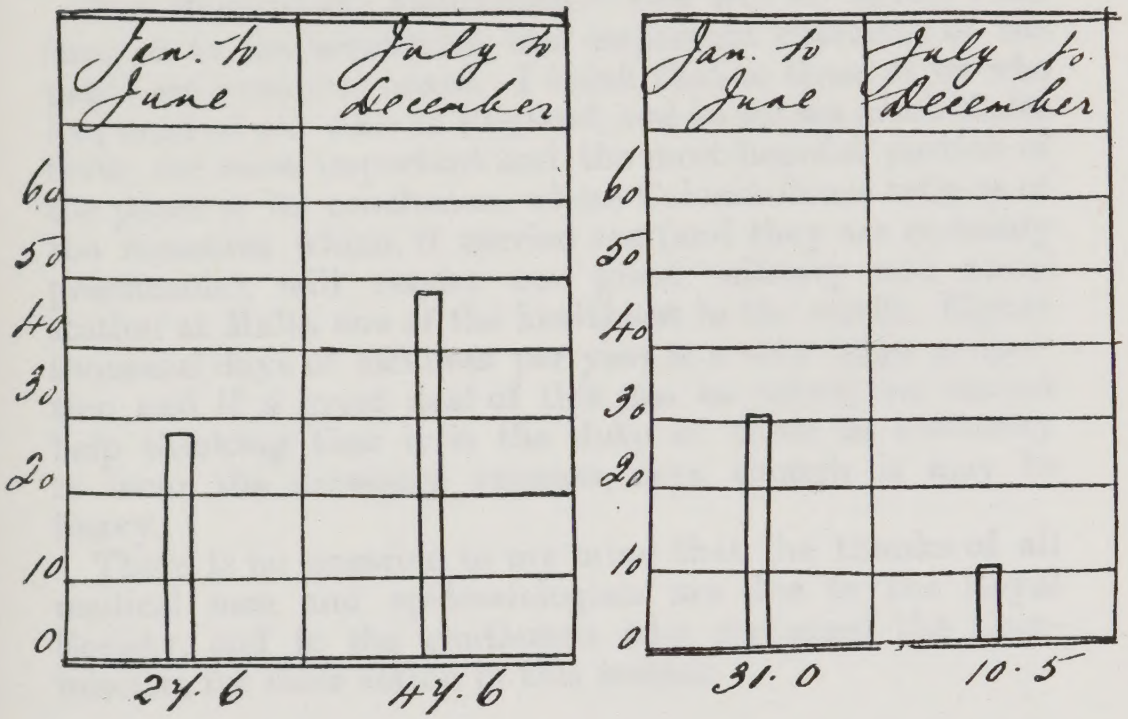



1906.



*Half-Yearly Prevalence.*

1899 to 1905. 1906.




with milk were examined, and several of them found to be excreting the Micrococcus in their milk. Goats' milk was forbidden, and from that date not a single case has occurred or can be traced to residence in this hospital.

## Conclusions.

Taking all these facts and arguments into consideration, there is, I think, reasonable ground for the hope that Malta fever will now disappear from the Army and Navy in Malta, and some 70,000 or 80,000 days of severe illness be blotted out from the yearly medical reports of the Army and Navy. This much-to-be-desired result, which, in my opinion, must come off if the Maltese Government only take the necessary measures, will change Malta from one of the unhealthiest and most dangerous stations in the British Army to one of the most salubrious; and you will agree with me that the Royal Society and the members of the commission are to be congratulated on the successful issue of the investigation.

## Discussion on Colonel Bruce's Paper.

The President: Gentlemen,—You will all agree, I am sure, as to the interesting and important character of the paper we have just heard. I think that to those of us who live most of our time in England, and do not see much Malta fever, the most important and the most hopeful portion of the paper is its conclusion, where Colonel Bruce tells us of the measures which, if carried out (and they are certainly practicable), will render our great military and naval station at Malta one of the healthiest in the world. Eighty thousand days of sickness per year is a very large proportion, and if a great deal of this can be saved, one cannot help thinking that it is the duty of those in authority to incur the necessary expense, even though it may be heavy.

There is no question in my mind that the thanks of all medical men and epidemiologists are due to the Royal Society, and to the gentlemen who composed the Commission, for their action in this matter.

Colonel Macpherson: I did not come here with the intention of entering into the discussion on this subject, because I am sure we all acknowledge that Colonel Bruce is practically our sole authority on the subject of Malta fever, and I was not aware of the arguments he was going to bring forward, except the one which we now recognise is the most important of all, namely, the question of goats' milk. I should only like to ask him whether he is perfectly satisfied, and whether the Commission of the Royal Society have satisfied themselves that it is only the Maltese goat that is the agent for the propagation of Malta fever. We know the disease is prevalent all along the Mediterranean coast, in Spain, in Italy, in Greece, and in Syria. I believe it has recently got the name of Mediterranean fever, because it is distinctly associated with the Mediterranean littoral. We know that that littoral is associated with the goat, which is the principal, indeed, almost the only, milk-giving animal. Colonel Bruce brings forward Major Horrocks's statistics for Gibraltar, and says that when goats ceased to be imported from Malta to Gibraltar the fever disappeared from Gibraltar; one is thereby led to believe that it is only the Maltese goat that can propagate the disease.

I do not think the facts that Colonel Bruce has brought forward with regard to Gibraltar are sufficiently conclusive.

I was in Gibraltar in the same capacity as Major Horrocks —as Health Officer—from 1890 to 1897, and I noticed at that time the sudden disappearance of both Malta fever and continued fever. Now Colonel Bruce says that Malta fever was very prominent twenty years ago; but Malta fever did not appear in any of the records twenty years ago. We only had records of simple continued fever. We called everything continued fever that was not of short duration. I do not think it is right to say that because that simple continued fever suddenly dropped in Gibraltar at a certain time, that therefore it was Mediterranean fever that disappeared. That sudden drop in simple continued fever occurred in the year 1886, and it was extremely sudden. (I am talking only of the statistics of the military population, of course we had no statistics of the civil population to help us in any way.) With regard to the military population, the admission rate of continued fever up to 1886 was almost continually something like 700 per thousand per annum; it was a constant ratio, and did not fluctuate much. Then suddenly it dropped, and in 1887 (I am open to correction as regards the actual year) it dropped down to about 100 per thousand and remained at that rate for a long time afterwards. During the time I was Health Officer it kept on getting lower. Goats existed and were very numerous; they were, in fact, the sole source of milk supply, except a few cows which were kept for special cases and families. Goats' milk is brought to the houses in the same way as in Malta, as Colonel Bruce has just graphically described to us. Now these goats were all kept by Maltese; they were not kept by Spaniards. I never knew myself the difference between Maltese and Spanish goats. What I should like to ask Colonel Bruce is: how far are we to accept the Maltese goat as alone the cause of Maltese fever, or how far must we allow the Spanish goat and other goats to cause it? If the Spanish goat or the mongrel goat on the Rock at Gibraltar do not cause the disease, and if Malta fever has disappeared from Gibraltar on account of the Maltese goat having disappeared, then I think that there is room for further investigation as to whether it is only the goat that exists in Malta that is able to propagate the fever.

COLONEL MELVILLE: There is only one point upon which I should like to make a remark, that is, as to the prevalence of Malta fever in India. Malta fever has been reported

from the Punjaub several times, and especially from some stations in the Punjaub. Now the goat exists there, but goats' milk is not drunk as goats' milk, and certainly the greater part of the milk we have there is cows' milk. If Colonel Bruce has any information as to Malta fever in India and its connection with the goat there, I should be glad to know what it is.

CAPTAIN KENNEDY: There are two things that especially interest me in these reports. (I take it for granted that these reports are published since the Colonel has read this paper.) I should like to refer to one thing which is not reported here. With reference to the cases of Malta fever occurring in hospitals, a great many seemed to occur among cases of venereal disease, and that struck me as being a very important point of investigation. I therefore went into the subject of the prostitutes there, and at the same time Dr. Eyre came out and helped me in the investigation. We found that a great many of them were suffering from Malta fever, and we came to the conclusion that it was quite possible that the soldiers might contract the disease through this agency.

Then there is another point, with regard to the urine. The excretion of the *Micrococcus melitensis* in the urine is very peculiar. It occurs just when the temperature is coming down to normal, and it occurs in very great quantities. This excretion may go on for a very long period of time; it may last for a year or even eighteen months. This is a very important factor, I think, when we take into consideration the epidemiology of the disease. I do not think (as Colonel Bruce says) that it will be an easy matter to eradicate the disease from Malta when you take into consideration such a fact as that.

DR. FRANKLIN PARSONS: I should like to ask whether the micrococcus in milk could not be destroyed by boiling, and if so, whether boiling the goats' milk might not be a simple and easy precaution?

I should also like to know how long the goat continues to yield milk contaminated by the Micrococcus, and whether it can be told by the agglutination test when a goat has passed through this fever; if a goat that has once passed through the fever is protected against it, that goat's milk might apparently be used. Assuming the thesis that the disease is mainly spread by milk, these two expedients

might possibly help to check the disease in places where it is impossible to prohibit the use of milk altogether.

Dr. Meredith Richards: I should like to ask Colonel Bruce how he can explain the case of Malta fever that occurred in Croydon last summer. The patient was brought into Croydon Borough Hospital, and she was supposed to have enteric fever, but she was not suffering from enteric fever, as was clear from the reaction to the serum agglutination test. The history of the case was as follows: The patient was a domestic servant. She had left Malta on July 2nd with her mistress, who had suffered from Malta fever at Malta. On the 10th July her mistress had a relapse, and my patient attended this mistress on and off until August 1st. On August 1st she had symptoms which were supposed to be those of enteric fever, but which were undoubtedly those of Malta fever. She was in hospital for three or four months, and she had several typical relapses. The interesting point of the case is that either the incubation period was longer than that of Malta fever generally, or else it is sometimes possible (contrary to the statement in the paper) for the disease to be contracted from person to person in England.

Dr. Carnegie Brown: I think we must all admire the excellent way in which Colonel Bruce seizes the salient epidemiological points in connection with Malta fever.

I should like to say, in connection with the remarks of the last speaker and of Colonel Melville, that most men who have seen much of diseases in the East Indies are familiar with a type of fever that prevails there, which is extremely like Malta fever in its general clinical features. There is the same long-drawn course, the same ladder-like rises of temperature, the same graduated descent through similar periods of reaction, and the same exacerbation and repetition of all the phenomena. There are no parasites to be found in the blood, and the disease is not amenable to treatment by quinine or any other anti-periodic. Most of these cases drag on for many weary months. Treatment does not influence the disease in any way, and the fever gets well, as it is colloquially expressed, by wearing itself out. In my own experience of the disease I have not seen any cases exhibiting the particular inflammation, the large number of leucocytes, or any other of the symptoms which are described as accompanying Malta fever. But this fever affects all races, all ages, and both sexes, and it

is by no means uncommon in children. It was natural, I think, that when the nature and the character of Malta fever was first elucidated by Colonel Bruce, that this affection, which presented such remarkable clinical features, should be supposed to be Malta fever; that a considerable amount of attention should be attracted to it, and that attempts should be made by means of agglutination tests and by leucocyte counts to determine its actual relation. Speaking for myself, I came across two occurrences of *Micrococcus melitensis*, one of which came from Netley, and the other from Kasauli. I found that in 80 per cent. the Micrococcus was agglutinated by the blood serum with a dilution of 1 in 50. I think this was the general experience, and the belief then became general that not only was Malta fever extremely prevalent, but that this was an extremely good and decisive test and criterion for its existence. That belief, I think, was fairly generally accepted, but doubts very soon began to arise. It was soon declared that a fever which is known in the East Indies as Kala-azar was Malta fever—that Kala-azar was epidemic Malta fever. But most of us who were familiar with Kala-azar knew that this type of fever was not only different, but that there could be no possibility of confusing the two diseases. One is more severe, and is marked by enlargement of the spleen, whilst in the other the spleen is not enlarged. It was upon the evidence of leucocyte counts and upon agglutination that Kala-azar was declared to be Malta fever. But the demonstration of the actual nature of Kala-azar, viz., that it is a protozoal infection, has demolished that contention. At the same time it has given a severe blow to the reliability of agglutination tests in the case of the *Micrococcus melitensis*, and, consequently, to the belief that this prevalent fever of the East is Malta fever. The report of the Mediterranean Fever Commission of 1905 has further accentuated the points of difference, for it is certain that the disorder of which I speak frequently occurs in people who do not take goats' milk in any form.

I do not know if I have made myself clear, but the points I have ventured to emphasise are that there is at least one prevalent fever in the Eastern tropics which bears a strong clinical resemblance to Malta fever, that its agglutination reactions with *Micrococcus melitensis* may be identical, that differential leucocyte counts may also show an altogether remarkable similarity, but that it is not and cannot be true Malta fever. The pathogenic Micrococcus

has not being isolated, and it is certain that the fever is of frequent occurrence amongst people who do not take milk—goats' or cows'—in any form. The inference is that too much reliance should not be placed on the diagnostic value of agglutination and differential leucocyte tests. The belief that Malta fever is indigenous and prevalent in the East Indies must be abandoned for the present.

THE PRESIDENT: I am sure you will wish me to say to Colonel Bruce on your behalf that the Society is very much obliged to him for his interesting and instructive paper.

Before I call upon him to reply, I should like to ask him whether the disease is attended with very heavy fatality? Also, does the fatality vary with the season or locality?

COLONEL BRUCE: In answer to the President's question the mortality of Malta fever is comparatively slight, and may be put down at 2 per cent. It is a comparatively non-fatal disease, but it makes up for this by its long duration and painful character.

Colonel Macpherson asks if it is only the Maltese goat which propagates Malta fever. To this I would answer "No," as probably all goats are susceptible. It may, however, be the case that only in Malta is there such a widespread infection of the goats.

In regard to his statement that the disease is prevalent all along the Mediterranean coast, in Spain, Italy, Greece, etc., I am not sure that in this he is correct. Shaw travelled along the south coast of France and along Italy, and nowhere did he find any trace of the disease. We do know that it occurs in Tunis, Algiers, and Alexandria, but these places are much frequented by Maltese and Maltese goats.

I must refer Colonel Macpherson to Major Horrocks's paper on the disappearance of Malta fever from Gibraltar *pari passu* with the disappearance of the Maltese goat; but, in my opinion, a fairly good case has been made out. Probably other factors came into play, but I have no doubt the Maltese goat played a prominent part. Major Horrocks is still working in Gibraltar on this subject, and will probably give us many more interesting observations on this important question.

In regard to Colonel Melville's question as to the connection between Malta fever and goats' milk in the Punjaub,

in India, I am sorry we have very few new facts to go on at present. No doubt when Major Lamb has finished his present plague investigation he will find an opportunity of returning to the question of the causation of Malta fever in India. Of course the Maltese goat may travel far. When I was at the Victoria Falls, on the Zambesi, eighteen months ago, I met Sir Charles Metcalfe, the Consulting Engineer to the Cape to Cairo Railway. He told me they had introduced Maltese goats into Rhodesia and with them Malta fever. In the same way the disease may have been introduced into the Orange River Colony, where it doubtless exists, as Dr. Strachan has recently shown. Did any of the Rhodesian goats find their way into the Orange River Colony, or is the disease indigenous there? In my paper I have shown what a determined effort the Americans made to introduce the disease into the neighbourhood of Washington.

Captain Kennedy is evidently of opinion that there may be other important factors in the spread of this disease than goats' milk. He may, of course, be right in this; but as practical men, now that we have discovered an undoubted and most dangerous source of infection, it is our duty to concentrate our attention on it, and by making the Maltese goats healthy, to see what effect that has on the incidence of the disease. If after the disappearance of the infected goat many cases of Malta fever still occur, then we must take up again the investigation of its etiology.

In answer to Dr. Franklin Parsons, I beg to say that, of course, boiling the goats' milk will kill the *Micrococcus melitensis*. The difficulty is to get the natives to take this simple precaution. In the Naval Hospital it was supposed that the milk was boiled thoroughly, yet the man in charge of the laboratory took the milk one day and found the living Micrococcus in it. The boiling may be done as a rule, but the herd comes late one morning and there is a hurry for the milk, and the Maltese servant decides that he will take the milk as boiled already.

It is not exactly known how long the goat continues to excrete the Micrococci in the milk, but this certainly takes place for a long time—months, or even years.

Dr. Meredith Richards asks me to explain the case of Malta fever which occurred at Croydon last summer. There has been some evidence brought forward of late to show that the incubation period may be much longer than the fifteen or twenty days which is usually accepted. Major

McCulloch treats on this subject in his report, and I would refer Dr. Richards to it. In my opinion a long incubation period would best explain his case.

Dr. Carnegie Brown took up the question of the reliability of the agglutination test in Malta fever. I would refer him to a paper of Bassett-Smith's on this subject in the Reports. Shortly, I would state that in the hands of a careful, qualified observer, I consider the test practically reliable.